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School Improvement in MARYLAND

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ASSESSMENTS

DATA ANALYSIS

INSTRUCTION

SCHOOL IMPROVEMENT

USER GUIDES

Using the Core Learning Goals: Algebra/Data Analysis

Functions & Algebra | DATA ANALYSIS & PROBABILITY

Lesson Plan: Lesson plans were written by Maryland mathematics educators and could be used when teaching the concepts.

Goal 3 Data Analysis And Probability

Expectation 3.1 The student will collect, organize, analyze, and present data.

Indicator 3.1.2 The student will use the measures of central tendency and/or variability to make informed conclusions.

Lesson Content

Making Informed Decisions Using Measures of Central Tendency

Objective

- The students will be able to calculate the mean, median, mode, range, and interquartile range for a set of data; create a box and whisker plot using paper and pencil and technology; and determine which measure of central tendency is the most helpful in a given situation.

Materials Needed

- Worksheet/Answer Key: Which Class is the Best?
- Graphing calculator

Calculator Skills

Enter data in a list; calculate the mean, median and range; and create a box and whisker plot.

Assessment

- Drill
- Class discussion

Lesson Structure

Development of Ideas

Have students answer the questions about the three box and whisker plots shown on the student sheet. Students may answer the questions individually or in a group. Answers should be discussed as a class.

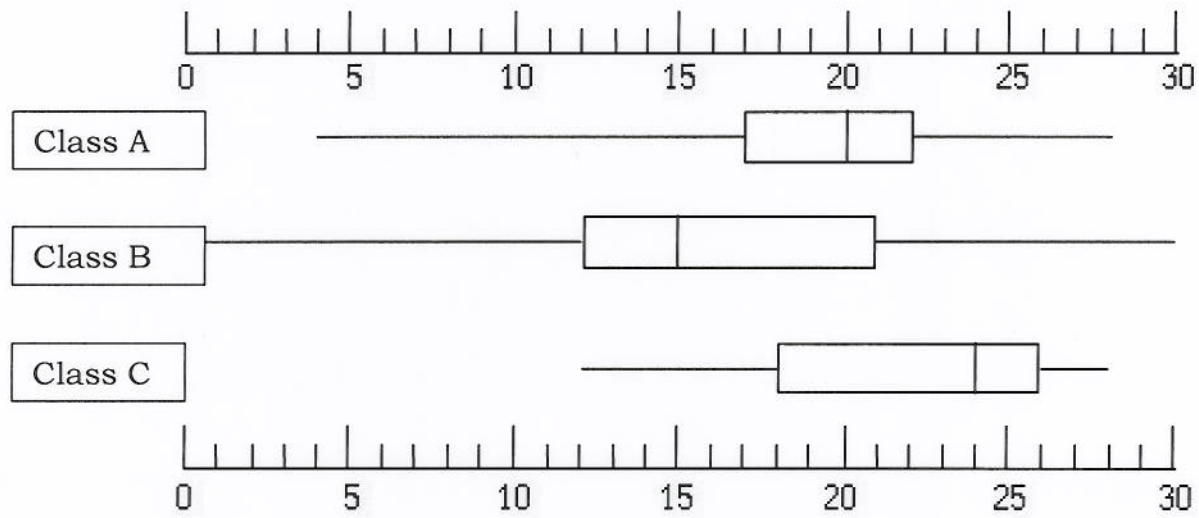
The emphasis of this lesson is on choosing the measure of central tendency which most appropriately represents the data. Basically, median works best in most situations because, unlike mean, it is not affected by outliers. For example this set of data: 2, 10, 11, 11, 12 has a median of 11 and a mean of 9.2. Eleven is a better representation of the most typical number in this set. In other instances, the mean and the median may be so close together that either one would be a good representation.

Closure

What information does a box and whisker plot show you? How can you use box and whisker plots to make comparisons? Under what circumstances is it better to use the median rather than the mean to represent a set of data? Under what circumstances is it better to use the mean rather than the median to represent a set of data?

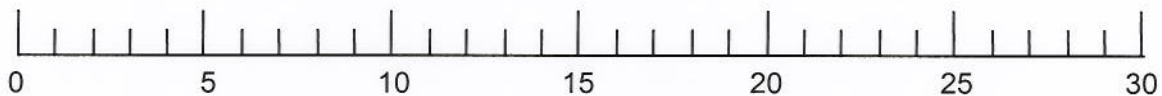
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Which Class is the Best?



The box and whisker plots above show the results from a recent test in Algebra for three classes. Answer the following questions using the box and whisker plots.

1. Class A has 25 students, Class B has 28 students and Class C has 30 students. The three classes are competing against one another and the class which does the best on the test wins a pizza party. Who should win? Use mathematics to justify your answer.
2. Later it was discovered that for class C, Mrs. Lovelace curved the test and gave each student 10 more points than they actually scored. Show the actual (before the curve) box and whisker plot for class C. Use mathematics to explain how you determined your answer. Use words, symbols, or both in your explanation.



3. Looking at the new data for class C, does this change your answer in question #1? Use mathematics to justify your answer.

4. The mean test score for each class is as follows:
Class A: 19.04, Class B: 15.71, and Class C: 21.97 (rounded to the nearest hundredth)

The mean score reported for class C is the mean of the curved scores (10 points added to each score). What is the actual mean for class C? Use mathematics to explain how you determined your answer. Use words, symbols, or both in your explanation.

Does knowing the mean scores for each class change your decision about who should win? (Use the actual mean for class C.) Use mathematics to justify your answer.

5. Which measure of central tendency should be used to determine the class that wins the contest? (Use the actual mean for class C.) Use mathematics to justify your answer.

In each exercise, make a box and whisker plot for each set of data, then find the mean and mode. Determine which measure of central tendency best represents the data.

6. Top 10 Batting Averages 1999

American League		National League	
Nomar Garciaparra	.357	Luis Gonzalez	.379
Derek Jeter	.349	Bob Abreu	.336
Bernie Williams	.342	Sean Casey	.335
Edgar Martinex	.337	Jeff Cirillo	.332
Manny Ramirez	.333	Mark Grudzielanek	.326
Omar Vizquel	.333	Carl Everett	.326
Ivan Rodriguez	.332	Doug Glanville	.326
Tony Fernandez	.328	Todd Helton	.325
Juan Gonzalez	.326	Chipper Jones	.319
Rafael Palmeiro	.324	Vladimir Guerrero	.316

Which league should be considered the best hitting league? Which measure of central tendency, mean, median, or mode best describes the typical hitter in the American League? National League? Use mathematics to justify your answer.

7. Average Precipitation (in inches)

	Baltimore, MD	Miami, FL
January	3.0	2.0
February	3.0	2.1
March	3.8	2.4
April	3.1	3.0
May	3.6	5.9
June	3.5	8.8
July	3.8	6.0
August	4.0	7.8
September	3.5	8.5
October	3.0	7.0
November	3.2	3.1
December	3.3	1.8

Based on the data, which city would be the best city in which to live? Which measure of central tendency best describes a “typical” Baltimore month for precipitation? A typical Miami month? Use mathematics to justify your answer.

8. Top 10 States in Population (based on 1990 U.S. Census)

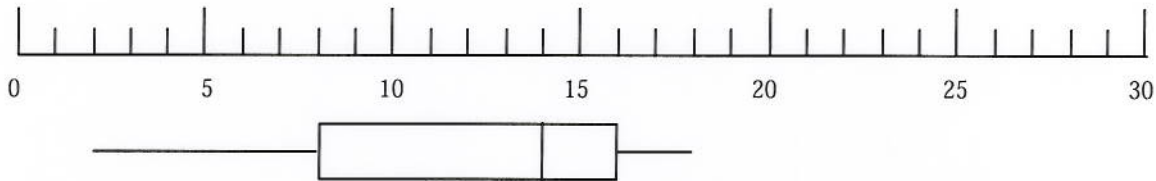
West (of the Mississippi)		East (of the Mississippi)	
California	29,786,021	New York	17,990,455
Texas	16,986,510	Florida	12,937,926
Missouri	5,117,073	Pennsylvania	11,883,000
Washington	4,866,692	Illinois	11,430,602
Minnesota	4,375,099	Ohio	10,847,115
Louisiana	4,222,000	Michigan	9,295,297
Arizona	3,665,228	New Jersey	7,748,000
Colorado	3,294,394	North Carolina	6,632,000
Oklahoma	3,145,585	Georgia	6,478,216
Oregon	2,842,321	Virginia	6,189,000

Based on the 1990 state populations, what can you conclude about the populations of the western states compared to the eastern populations? Which measure of central tendency best describes a typical western state population? Eastern? Use mathematics to justify your answer.

Which is the Better Class?

Answer Sheet

1. Sample response: Class C should win the pizza party because the median score is 24 which is greater than both of the median score for class A which is 20 and class B which is 15.
2. All values will be ten less than the curved scores.



3. Sample response: After looking at the new data for class C, I changed my mind and I think class A should win. Now class A has the largest median score which is 20, compared with class B which is 15 and class C which is 14.
4. Sample response: The new mean score for class C is 11.97. The old mean was 21.97, by taking 10 points off each person's score and dividing by the total, it would decrease the class mean by 10 points as well. $21.97 - 10$ is 11.97. Using the mean scores, I think class A should still win. The mean score for class A is 19.04 which is larger than both class B which is 15.71 and class C which is 11.97.
5. Sample response: For the overall results of the winner of the contest, it does not matter whether you use the mean or the median, class A would still be the winning class. The mean and the median are close in every class except class C. For class A, the mean is 19.04 and the median is 20. For class B the mean is 15.71 and the median is 15. For class C however, the mean is 11.97 and the median is 14. In this case, the median is a more accurate representation of the data for class C.
6. Outlier: .379 (Luis Gonzalez)

	Lower Extreme	Lower Quartile	Median	Upper Quartile	Upper Extreme	Mean	Mode
American	.324	.328	.333	.342	.357	.336	.333
National	.316	.325	.326	.335	.379	.332	.326

The best hitting league would be the American League because the median, mean and mode batting averages are greater in the American League than in the National League. The mean batting average for the American League is .336 and for the National League is .332. The median batting average for the American League is .333, which is greater than the median batting average for the National League, which is .326. The mode batting average for the American League is .333 and the mode average for the National League is .326. In this case, any of the three measures are good indicators of the data.

7. Outliers: NONE

	Lower Extreme	Lower Quartile	Median	Upper Quartile	Upper Extreme	Mean	Mode
Baltimore, MD	3	3.05	3.4	3.7	4	3.4	3.0
Miami, FL	1.8	2.25	4.5	7.4	8.8	4.87	None

Looking at both the median and the mean precipitation, Miami has a greater amount of precipitation than Baltimore for the year. The mean precipitation for Miami is 4.87 inches, which is greater than Baltimore's mean of 3.4 inches. The median precipitation for Miami is 4.5 inches, which is greater than the Baltimore median of 3.4 inches. But if you look at the box and whisker plots, Baltimore's precipitation is more consistent than Miami's. Deciding the "better" place for precipitation would depend on what kind of climate would be your preference. Either a year-long consistent amount of precipitation like Baltimore or precipitation which fluctuates like Miami. In this case, the mean, the median, or the mode for Baltimore all are good indicators a typical month in Baltimore for precipitation; however Miami's precipitation fluctuates so much from month to month, that it is difficult to decide what a "typical" month of precipitation would be in Miami. The median of 4.5 inches nor the mean of 4.87 inches accurately depicts the fact that in a month Miami could have either 8.5 inches of rain or 1.8 inches of rain. In this case, the mode would not be an option since there is no mode.

8. Outliers: 16,786,021 (CA) and 16,986,510 (TX)

	Lower Extreme	Lower Quartile	Median	Upper Quartile	Upper Extreme	Mean
West	2,842,321	3,294,394	4,298,549.5	5,117,073	29,786,021	7,830,092.3
East	6,189,000	6,632,000	10,071,206	11,883,000	17,990,455	10,143,161.1

Neither the west nor the east data have a mode.

The western states have a median of 4,298,549.5 compared to a median of 10,071,206 for the eastern states. Clearly the eastern half of the country is more populated. The mean for the western states is 7,830,092.3 while the eastern states have a mean of 10,143,161.1. For the eastern states, the mean and the median are fairly close to each other and either one represents the population of the states well. However, for the western states, the mean is over 3,500,000 more than the median because California and Texas are outliers and increase the mean. In this case, the median is a better representation of the population of the western states.